

Claims:

1. An apparatus for hematology testing, comprising:
a sensing unit defining a counting orifice for the flow of a blood sample through the counting orifice to analyze the blood sample; and
a pump unit including at least two syringes, a first syringe being coupled in fluid communication with the sensing unit on the inlet side of the counting orifice for injecting a stream of blood sample through the counting orifice, and a second syringe coupled in fluid communication with the sensing unit on the inlet side of the counting orifice for simultaneously injecting a sheath of fluid surrounding the sample stream on the inlet side of the counting orifice.
2. An apparatus as defined in claim 1, wherein the pump unit further includes a third syringe coupled in fluid communication with the sensing unit on the outlet side of the counting orifice for aspirating the fluids injected through the counting orifice from the outlet side of the counting orifice.
3. An apparatus as defined in claim 1, wherein the pump unit includes a drive motor coupled to both the first and second syringes for simultaneously actuating the syringes.
4. An apparatus as defined in claim 1, wherein the drive

motor is coupled to a threaded shaft and the threaded shaft is coupled to the first and second syringes, whereupon rotation of the drive motor causes rotation of the threaded shaft and simultaneous actuation of the first and second syringes.

5. An apparatus as defined in claim 4, wherein the drive motor is a stepping motor.

6. An apparatus as defined in claim 4, wherein the pump unit further includes a drive plate coupled between the first and second syringes and the threaded shaft, whereupon rotation of the shaft by the drive motor causes the drive plate to move in the axial direction of the shaft and simultaneously actuate the first and second syringes.

7. An apparatus as defined in claim 1, further including a first-position sensor located approximately at one extreme of permissible movement of the first and second syringes and a second-position sensor located at another approximate extreme of permissible movement of the first and second syringes, each sensor generating a signal when at least one of the first and second syringes reaches the respective extreme position of permissible movement.

8. An apparatus as defined in claim 1, further comprising a valve matrix coupled between the pump unit and the sensing unit

for controlling the flow of fluids between the pump unit and the sensing unit.

9. An apparatus as defined in claim 1, further comprising a control unit coupled to the pump unit and the sensing unit for controlling actuation of the syringes.

10. An apparatus as defined in claim 9, further comprising a first lysing agent chamber and a second lysing agent chamber, each being coupled to the pump unit for aspirating the lysing agents into at least one syringe of the pump unit.

11. An apparatus as defined in claim 10, wherein the control unit includes a database pertaining to predetermined quantities of lysing agents necessary for formulating blood/reagent mixtures for a plurality of species, and is responsive to an input indicating a specific species to control the pump unit to aspirate into at least one of the first and second syringes predetermined quantities of the lysing agents from the first and second lysing chambers corresponding to the respective species.

12. An apparatus as defined in claim 1, further comprising a sample probe coupled to at least one syringe of the pump unit for aspirating a predetermined volume of blood sample into the probe for testing.

13. An apparatus as defined in claim 10, further comprising a mixing chamber coupled in fluid communication with the pump unit for receiving the lysing agents injected by at least one syringe of the pump unit for mixing the lysing agents with a blood sample.

14. An apparatus as defined in claim 1, wherein the sensing unit includes a first injector tube coupled in fluid communication with the first syringe and located on the inlet side of the counting orifice for injecting the sample stream through the counting orifice, and a second injector tube coupled in fluid communication with the second syringe and located on the inlet side of the counting orifice for injecting the sheath fluid adjacent the sample stream.

15. An apparatus as defined in claim 14, wherein the sensing unit defines an inlet chamber coupled in fluid communication with the counting orifice, the first injector tube and the second injector tube, and at least a portion of the second injector tube is oriented substantially on a tangent to a surface defining the inlet chamber for injecting the sheath of fluid in a generally spiral path surrounding the sample stream.

16. An apparatus as defined in claim 2, wherein the sensing unit includes a sheath tube coupled in fluid communication with the third syringe and located on the outlet side of the counting orifice for aspirating a sheath of fluid through the sheath tube

surrounding the sample stream on the outlet side of the counting orifice.

17. An apparatus as defined in claim 16, wherein the sensing unit further defines an exit chamber coupled in fluid communication with the outlet side of the counting orifice for receiving the sample/sheath mixture injected through the counting orifice, and the sheath tube is coupled in fluid communication with the exit chamber, and at least a portion of the sheath tube is oriented substantially on a tangent to a surface defining the exit chamber for directing the sheath of fluid in a generally spiral path surrounding the sample stream on the outlet side of the counting orifice.

18. An apparatus for hematology analysis, comprising:
a sensing unit defining an orifice for receiving a sample stream of blood cells and a sheath of diluent surrounding the sample stream injected into the sensing unit; and

three positive-displacement pumps, each pump including a piston for injecting and aspirating fluid with the respective pump, a first pump coupled in fluid communication with the inlet side of the orifice for injecting the sample stream into the sensing unit on the inlet side of the orifice, a second pump coupled in fluid communication with the inlet side of the orifice for injecting a first sheath of diluent surrounding the sample stream on the inlet side of the orifice, and a third pump coupled in fluid

communication with the sensing unit on the outlet side of the orifice for aspirating a second sheath of diluent through the outlet side of the orifice surrounding the sample stream exiting the orifice.

19. An apparatus as defined in claim 18, further including means for directing at least one of the first and second sheaths of diluent in a substantially spiral path surrounding the sample stream.

20. An apparatus as defined in claim 19, wherein the means for directing includes a first sheath tube coupled on one end in fluid communication with the second pump and coupled on the other end in fluid communication with the inlet side of the orifice, and at least a portion of the first sheath tube is oriented substantially on a tangent to a surface defining a chamber on the inlet side of the orifice.

21. An apparatus as defined in claim 19, wherein the means for directing includes a second sheath tube coupled on one end in fluid communication with the third pump and coupled on the other end in fluid communication with the outlet side of the orifice, and at least a portion of the second sheath tube is oriented substantially on a tangent to a surface defining a chamber on the outlet side of the orifice.

22. An apparatus as defined in claim 18, further comprising a control unit coupled to the three positive-displacement pumps, and including a database pertaining to predetermined quantities of reagents corresponding to blood/reagent mixtures for a plurality of species, the control unit being responsive to an input selecting a particular species to control at least one pump to aspirate the predetermined volumes of reagents corresponding to the respective species.

23. An apparatus as defined in claim 22, further comprising a first chamber containing a first reagent and a second chamber containing a second reagent, the first and second chambers each being coupled in fluid communication with at least one pump for aspirating reagent from each chamber into at least one pump, and a mixing container coupled in fluid communication with at least one pump for injecting the predetermined quantities of reagents from at least one pump into the mixing container.

24. An apparatus for hematology analysis, comprising:
a pump unit comprising at least one positive-displacement pump including a piston for injecting and aspirating fluid with the pump; and
a control unit coupled to the positive-displacement pump, and including a database pertaining to predetermined quantities of reagents corresponding to blood/reagent mixtures for a plurality of species, the control unit being responsive to an input selecting

a particular species to control the at least one pump to aspirate the predetermined volumes of reagents corresponding to the respective species into the pump.

25. An apparatus as defined in claim 24, further comprising a first chamber containing a first reagent and a second chamber containing a second reagent, the first and second chambers each being coupled in fluid communication with the at least one pump for aspirating reagent from each chamber into the at least one pump, and a mixing container coupled in fluid communication with the at least one pump for injecting the predetermined quantities of reagents from the at least one pump into the mixing container.

26. An apparatus as defined in claim 24, further comprising a sample probe coupled to the at least one pump, the control unit being responsive to an input selecting a particular species to control the at least one pump to aspirate a predetermined volume of whole blood sample corresponding to the respective species into the pump.

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